Atmosphere

Earth's atmosphere

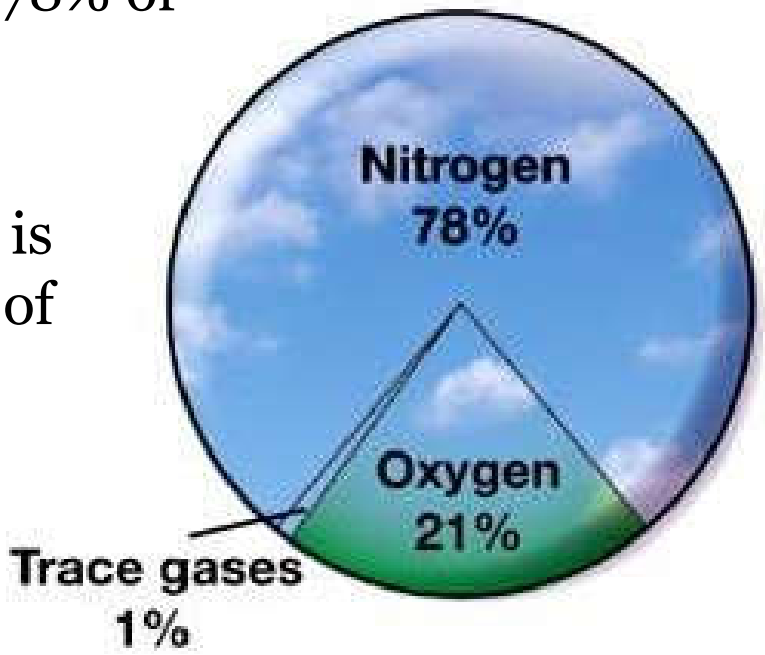
- *Earth's atmosphere is a layer of gases surrounding the planet.*
- *The Earth is surrounded by a blanket of air, which we call the atmosphere. It reaches over 560 kilometers from the surface of the Earth.*

Atmosphere:

- Absorbs the energy from the Sun,
- Recycles water and other chemicals,
- protects us from high-energy radiation and the frigid vacuum of space.
- The atmosphere protects and supports life.

Earth's atmosphere

- Earth's atmosphere is made of a mixture of gases called air.
  - **Nitrogen** gas makes up about 78% of Earth's atmosphere.
  - The second most abundant gas is **oxygen**, which makes up 21% of Earth's atmosphere.
  - The third **Argon** (Ar, 0.9%).
  - **Carbon Dioxide** (CO_2, 0.03%).



Composition of the Atmosphere

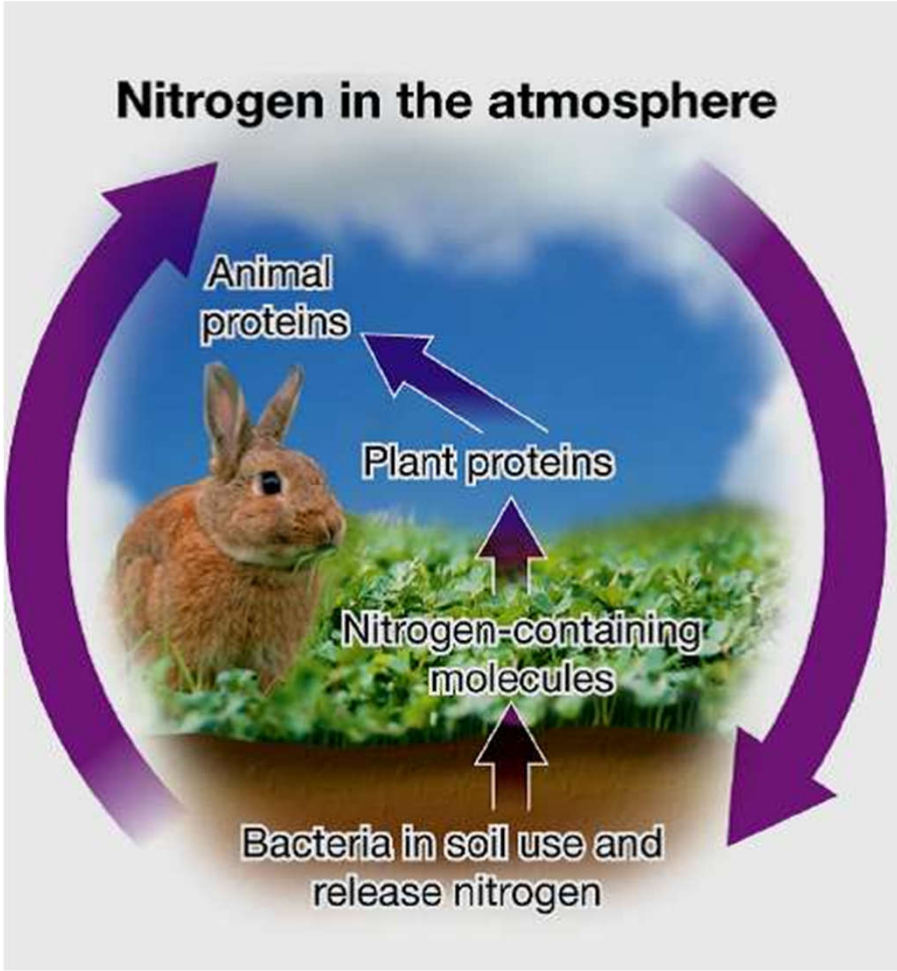
The atmosphere is comprised of a variety of gases:

- **Major Constituents (99%):**
  - Nitrogen (N): 78%
  - Oxygen (O_2): 21%
- **Trace Constituents:**
  - Argon (Ar), about 0.9%
  - Water vapor (H_2O), up to 10000 ppmv
  - Carbon dioxide (CO_2), 350 ppmv
  - Ozone (O_3), near zero at the surface, up to 10 ppmv in the stratosphere
  - Methane (CH_4), 1.7 ppmv
  - and others.....

ppmv = "parts per million by volume"

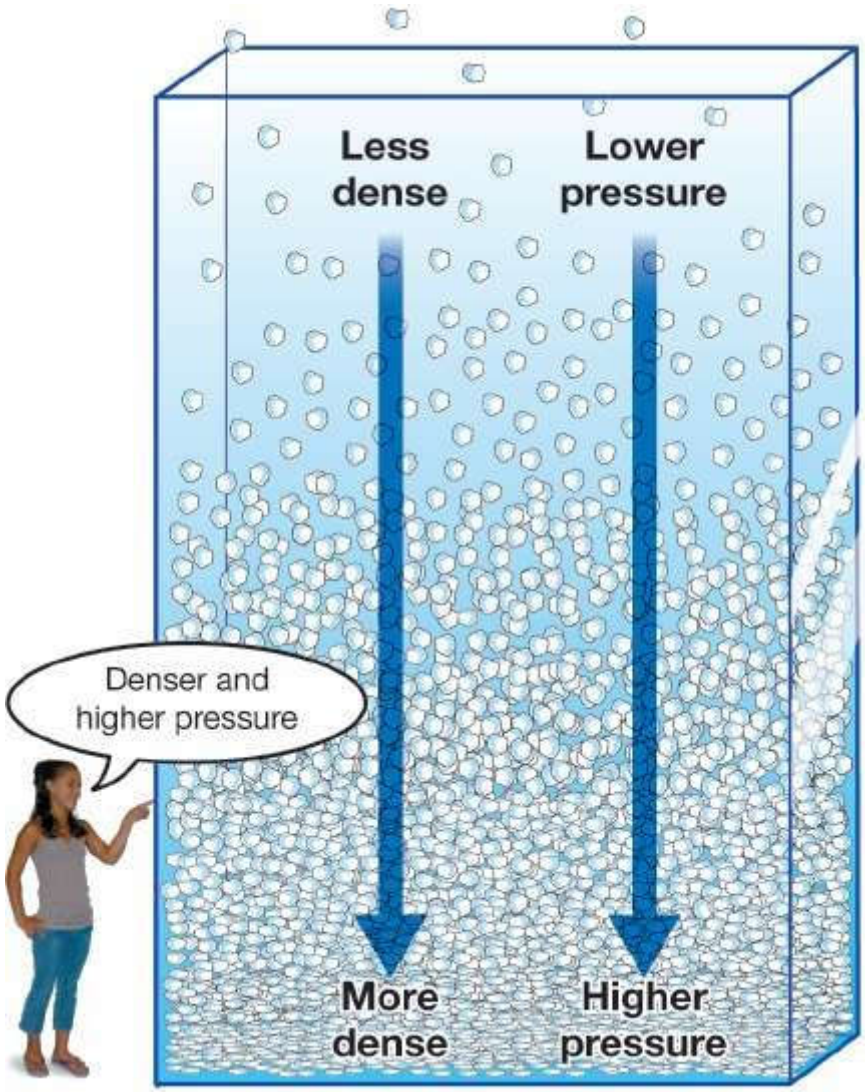
Nitrogen Cycle

- Nitrogen is important to protein which is found in the body tissues of all living things.
- Nitrogen is cycled through the soil and into plants and finally when living things die and decay.



Pressure in the atmosphere

- **Atmospheric pressure** is the force per unit area exerted into a surface by the weight of air above that surface in the atmosphere of Earth.
- The gas molecules closest to Earth's surface are packed together very closely.
- This means pressure is lower the higher up you go into the atmosphere.

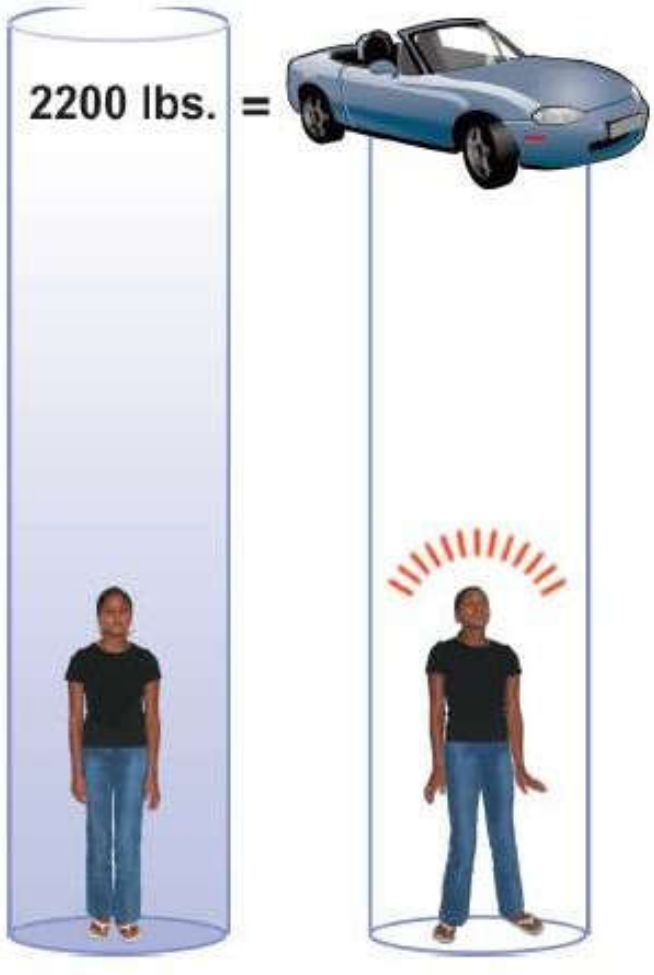


Pressure in the atmosphere

- At sea level, the weight of the column of air above a person is about 9,800 Newtons (2,200 pounds)!

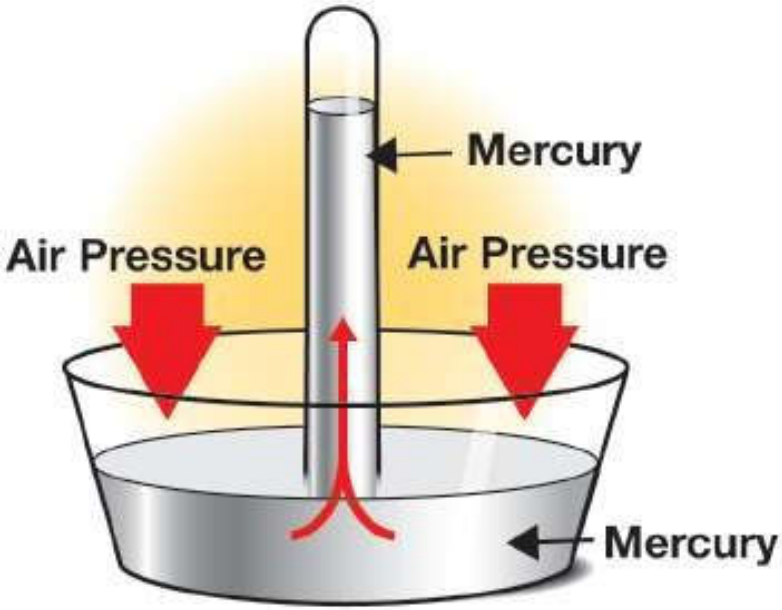
- This is equal to the weight of a small car.

- 1 atm = 14.69 pound/sq inch
- = 6.6 kg/ sq inch
- Other units of pressure are mm of Hg, millibar, pascal



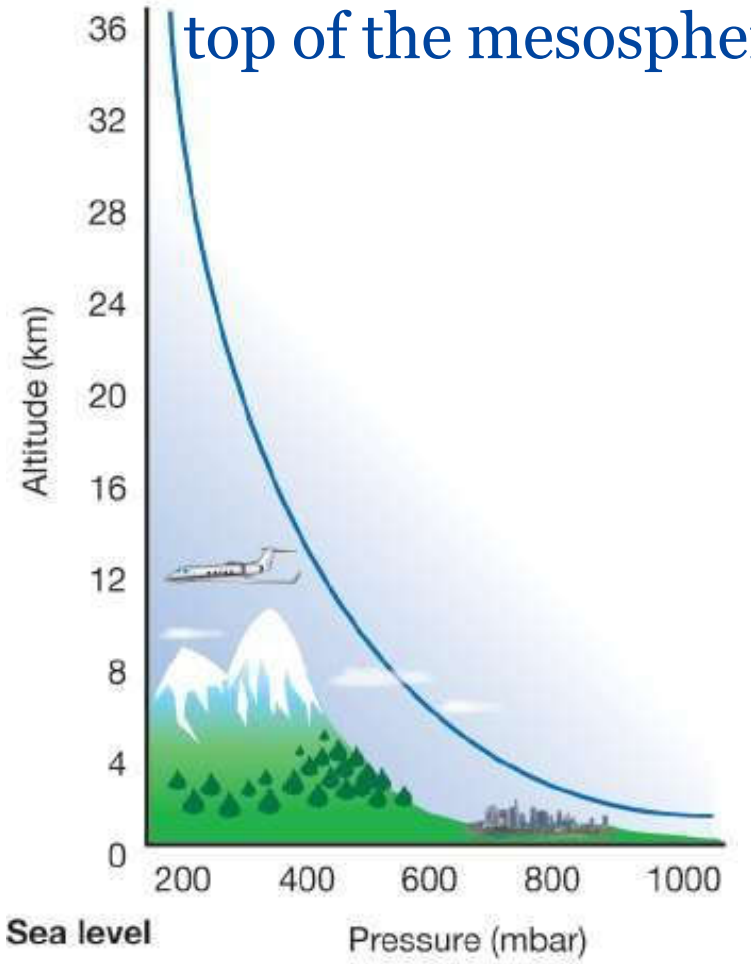
Measuring Pressure

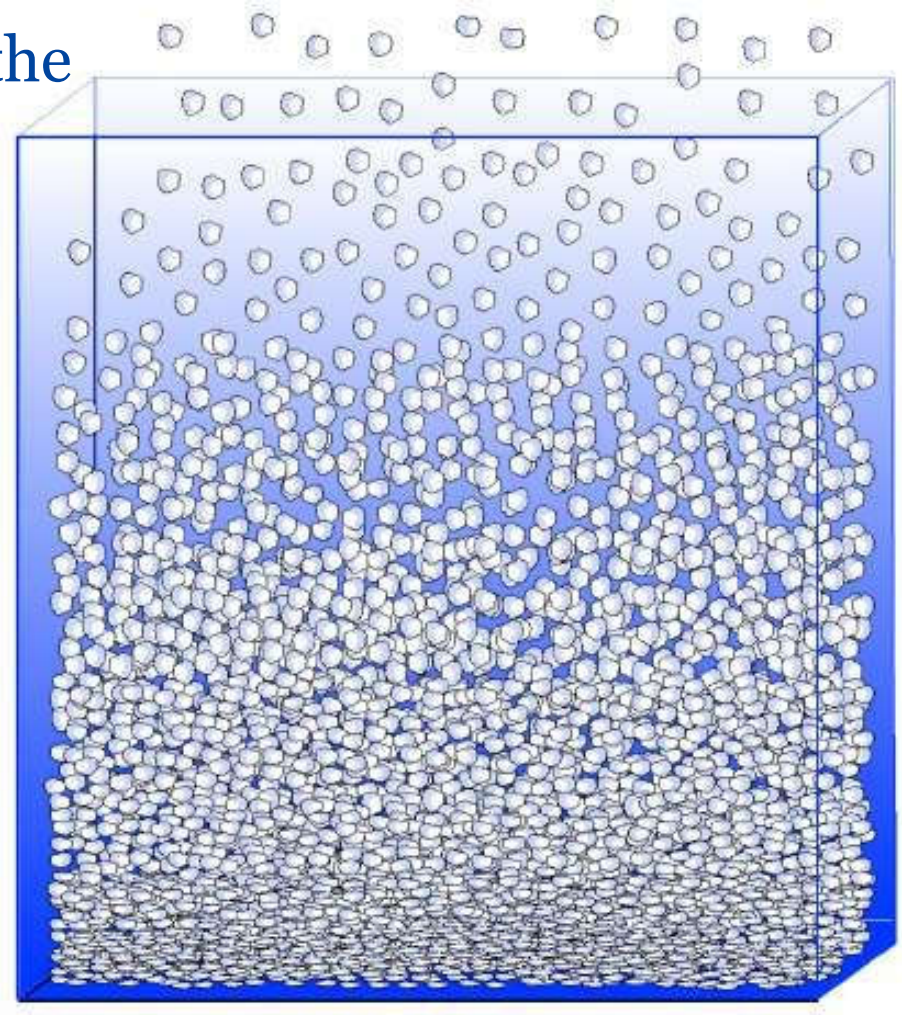
- A **barometer** is an instrument that measures atmospheric pressure.
- Long ago, mercury barometers were used
- Since mercury is a poisonous liquid, *aneroid barometers* are used today.



Pressure changes with altitude

Pressure varies smoothly from the Earth's surface to the top of the mesosphere.



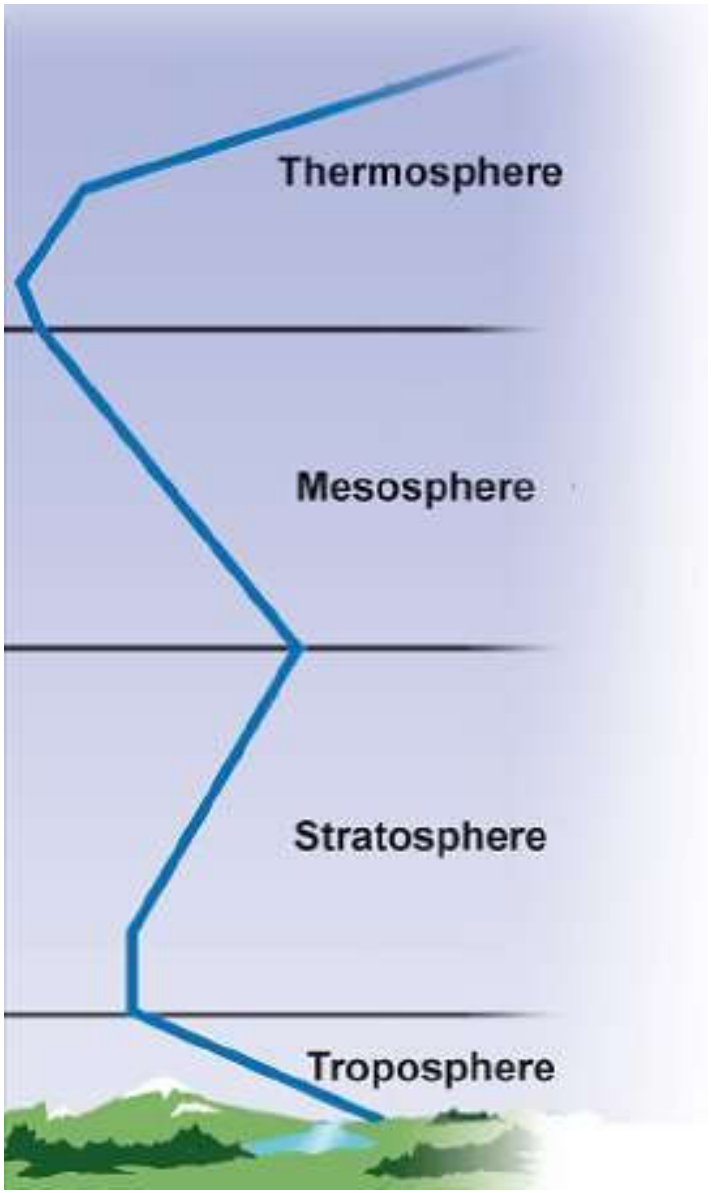



Layers of Atmosphere
thermosphere
mesosphere
ozone
stratosphere
troposphere

Layers of Atmosphere

The atmosphere has four layers

- Thermosphere
- Mesosphere
- Stratosphere
- Troposphere



Layers of Atmosphere

Troposphere

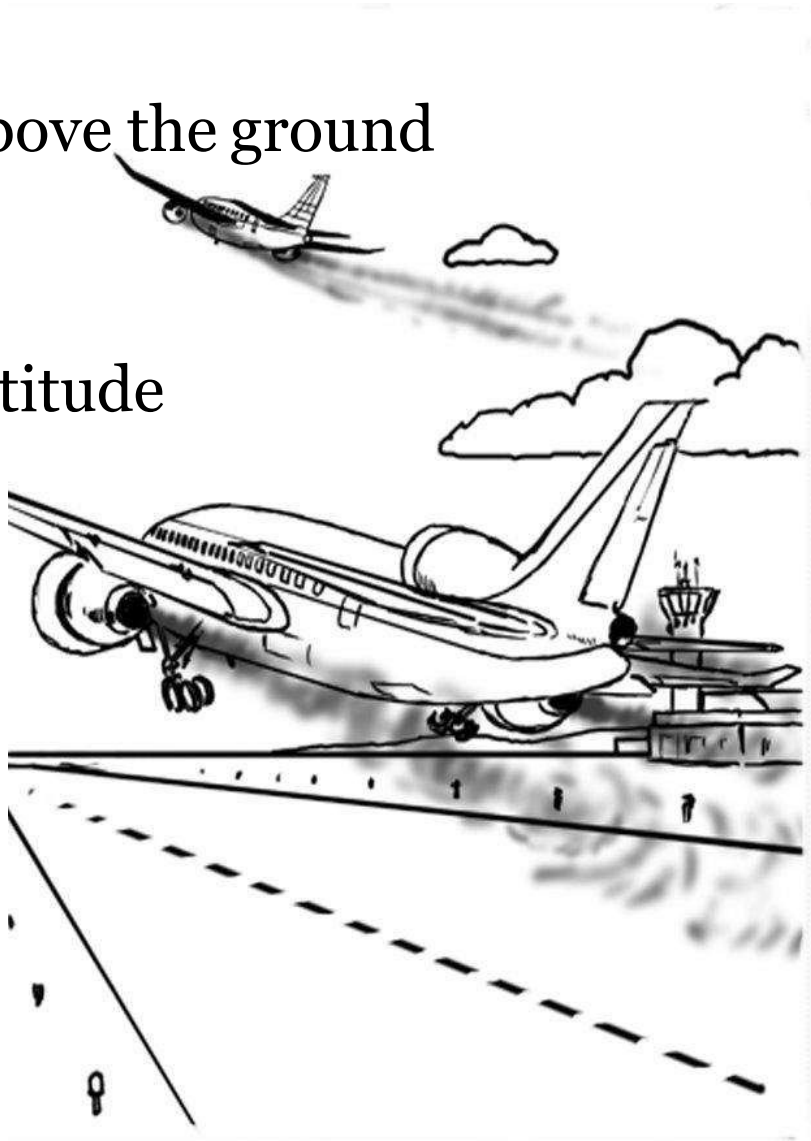
- Lowest and thinnest layer
  - 16 km at equator, 8 km at poles
- 90% of the atmosphere's mass
- Temperature decreases with altitude
  - 6°C per kilometer
  - Top of troposphere averages –50°C
- Where weather occurs
- Boundary between the troposphere, and the stratosphere is called the **tropopause**

View of troposphere layer from an airplane's window.

Layers of Atmosphere

Stratosphere

- Extends from 10 km to 50 km above the ground
- Less dense (less water vapor)
- Temperature **increases** with altitude
- Almost no weather occurrence
- Contains high level of ozone
  - **Ozone layer**
- Upper boundary is called **stratopause.**



Layers of Atmosphere

Mesosphere

- Extends to almost 80 km high
- Gases are less dense.
- Temperature decreases as altitude increases.
  - Gases in this layer absorb very little UV radiation.

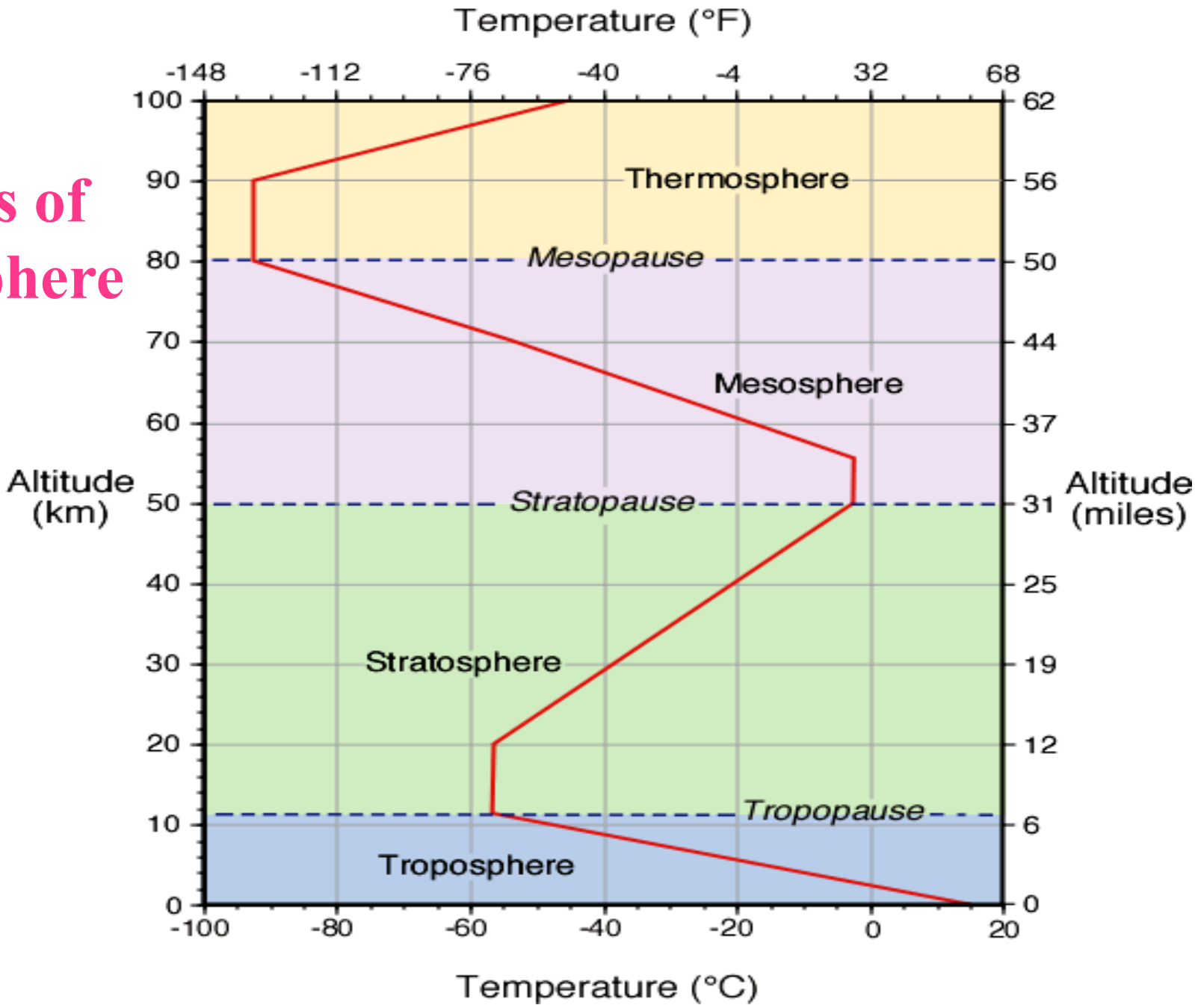
Layers of Atmosphere

Thermosphere

- Above the mesosphere and extends to almost 600 km high

- Temperature **increases** with altitude
- Readily absorbs solar radiation
- Temperature can go as high as 1,500 °C
- Reflects radio waves

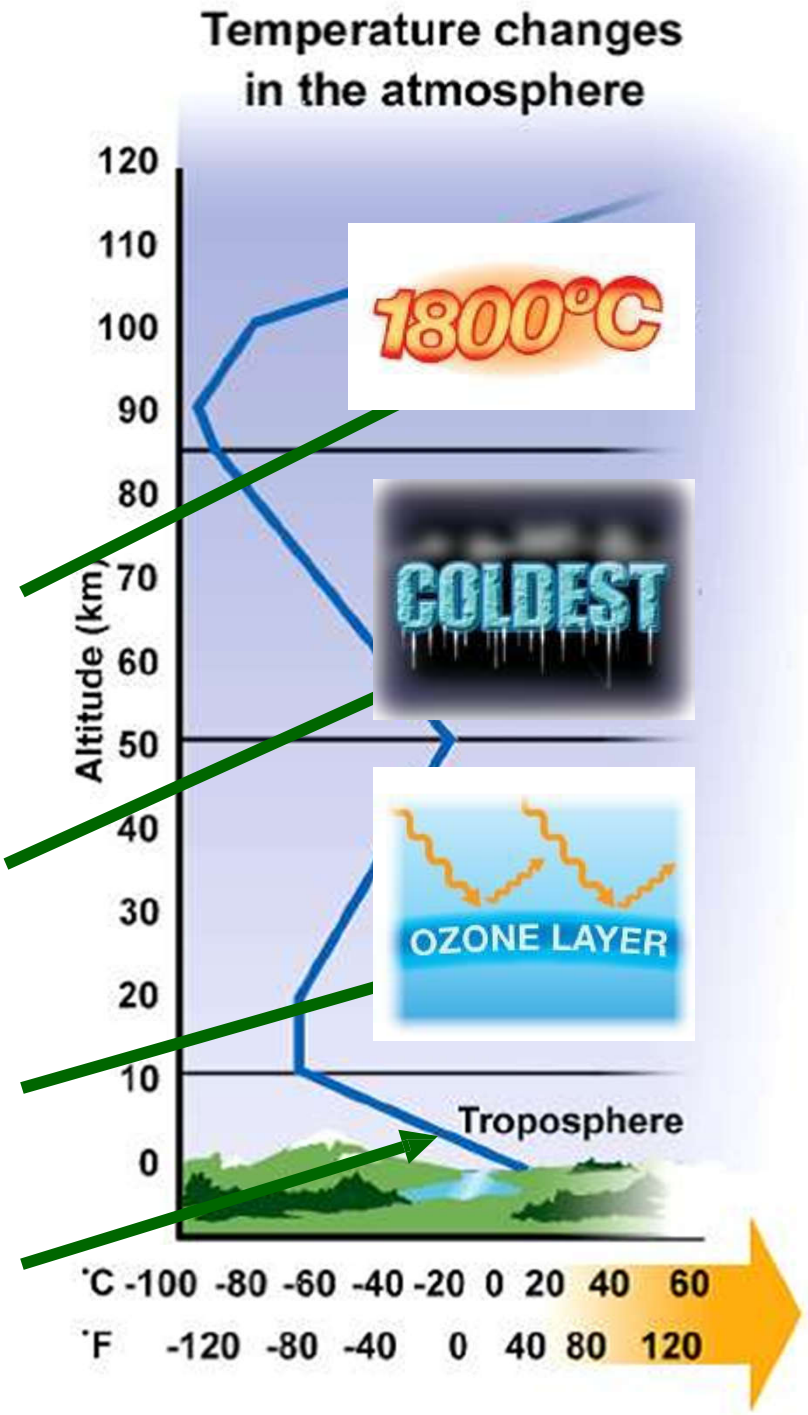
Layers of Atmosphere



Layers of the Atmosphere

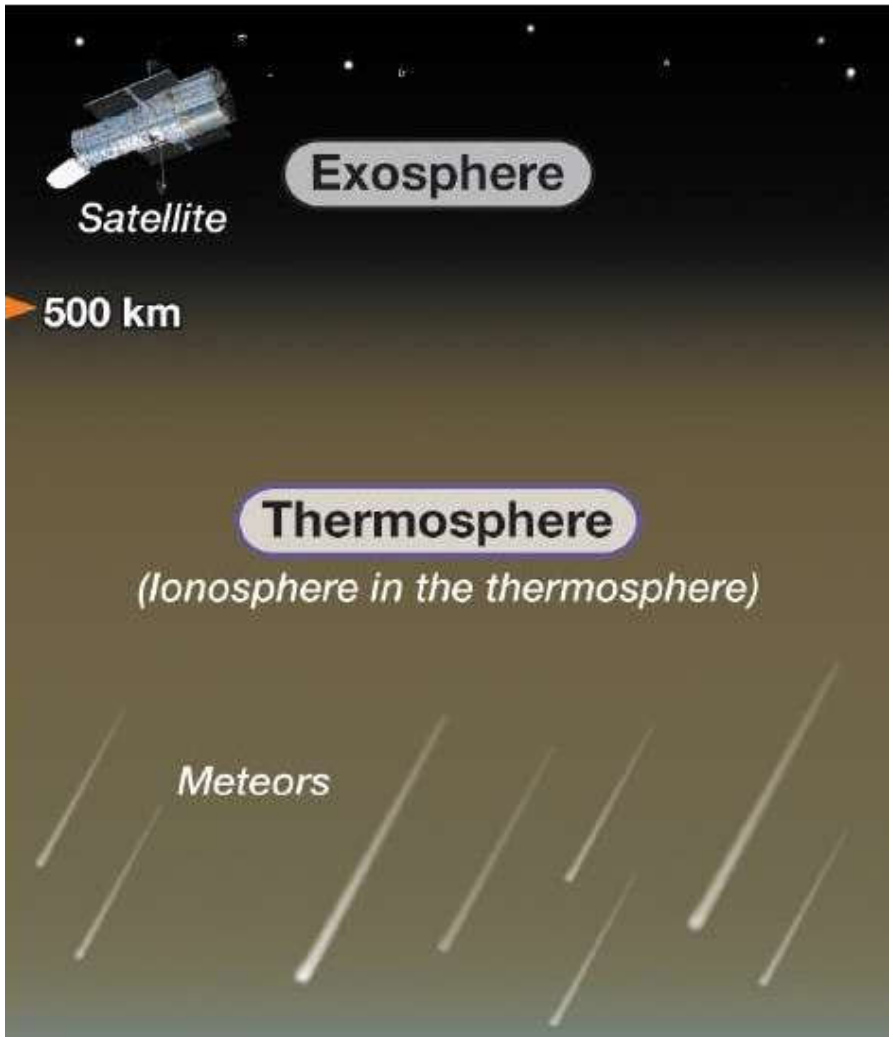
The four layers of the atmosphere include:

1. *the troposphere, where we live;*
2. *the stratosphere, which contains the ozone layer;*
3. *the mesosphere, where meteors burn; and*
4. *the thermosphere, where satellites orbit Earth.*



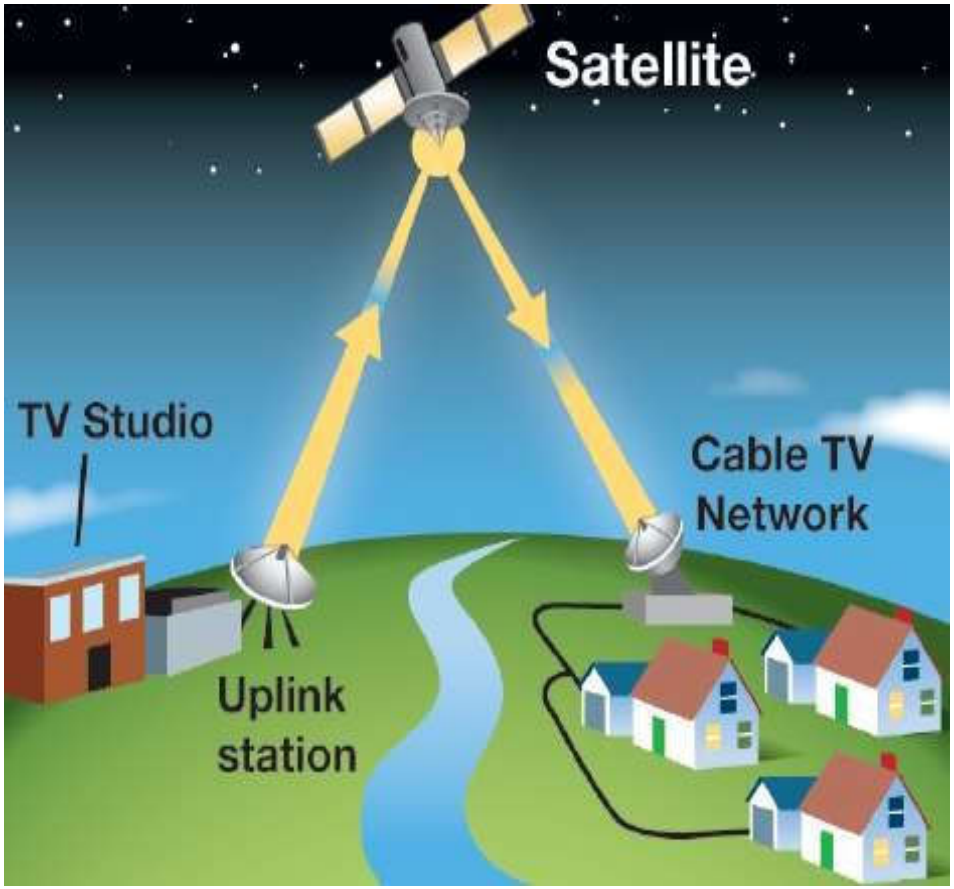
Layers of the Atmosphere

- The exosphere begins at about 500 kilometers above Earth and does not have a specific outer limit.
- Satellites orbit Earth in the exosphere.



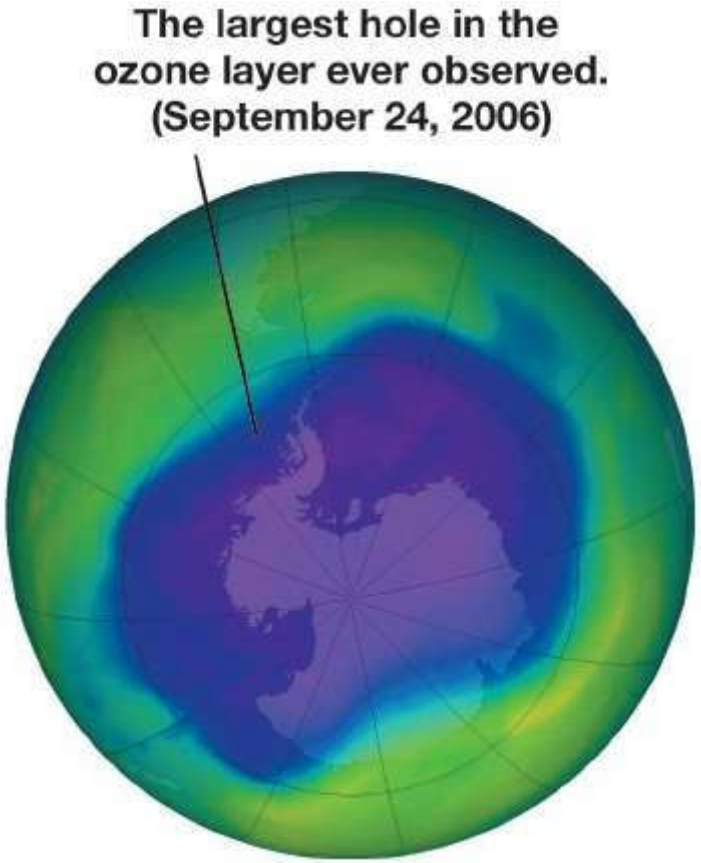
The exosphere and ionosphere

- Communication on Earth depends on satellites.
- Satellites transmit information used for television shows, radio broadcasts, data and photos used in weather reports, and long distance telephone calls.



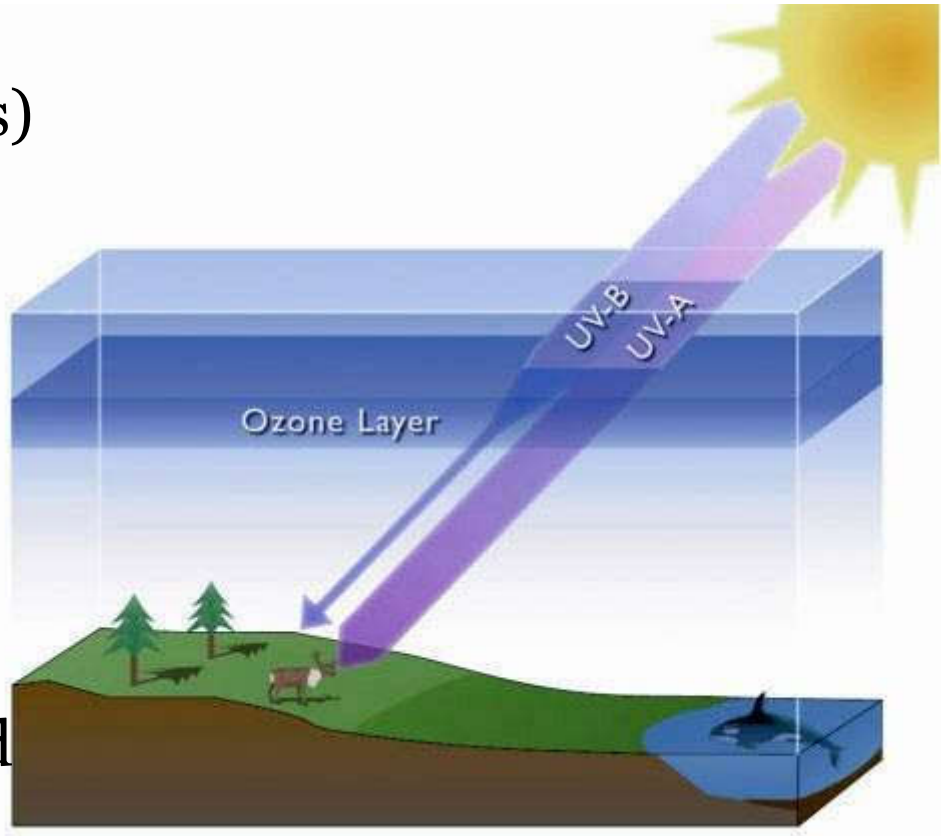
The ozone layer

- In the 1970s, scientists noticed that the ozone layer in the stratosphere above Antarctica was thinning.



Chlorofluorocarbons & the ozone layer

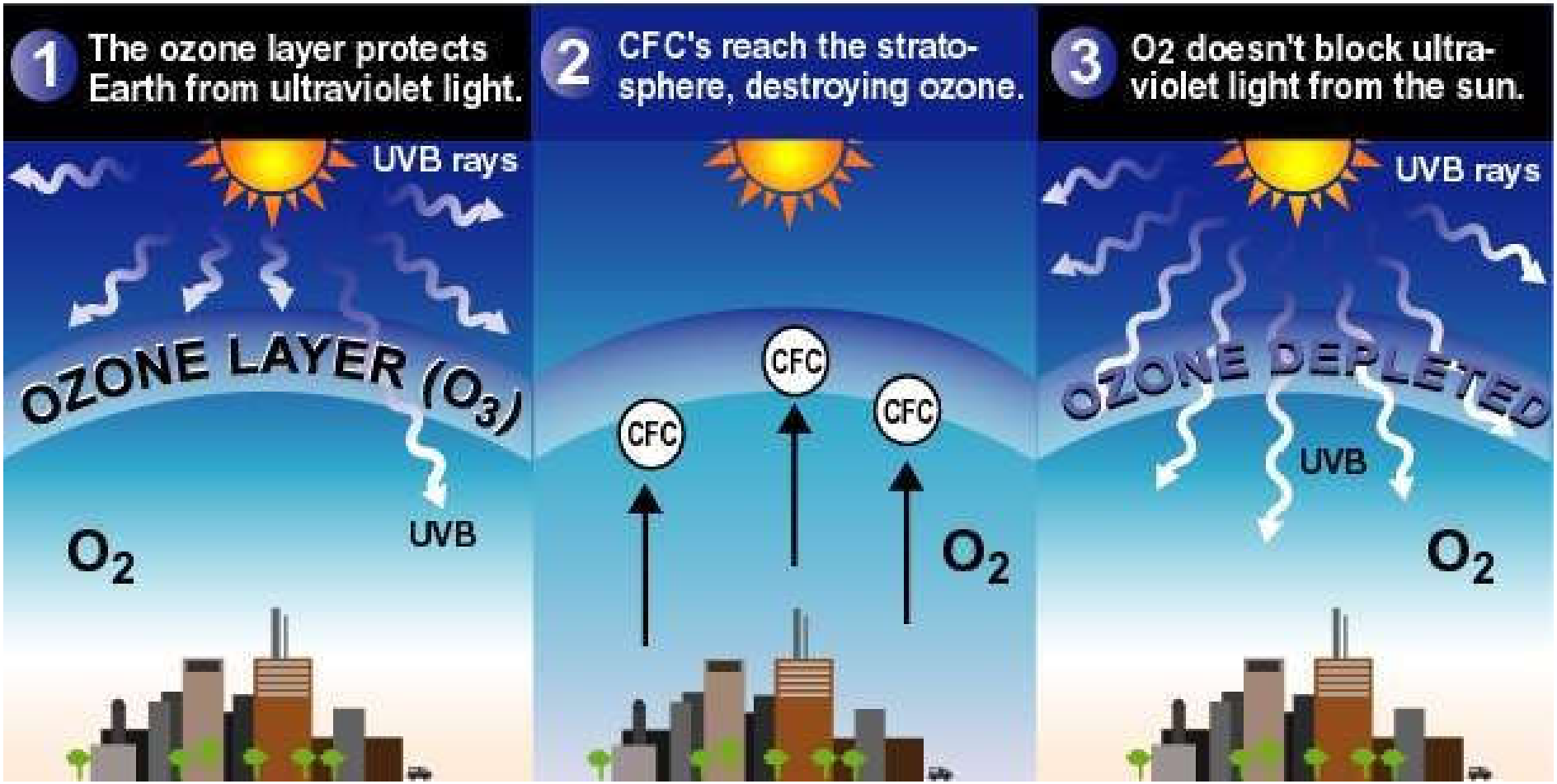
- A group of chemicals called chlorofluorocarbons (or CFCs) were once commonly used in air conditioners, in aerosol spray cans, and for cleaning machine parts.
- In the London Agreement of 1991, more than 90 countries banned the production and use of CFCs except for limited medical uses.

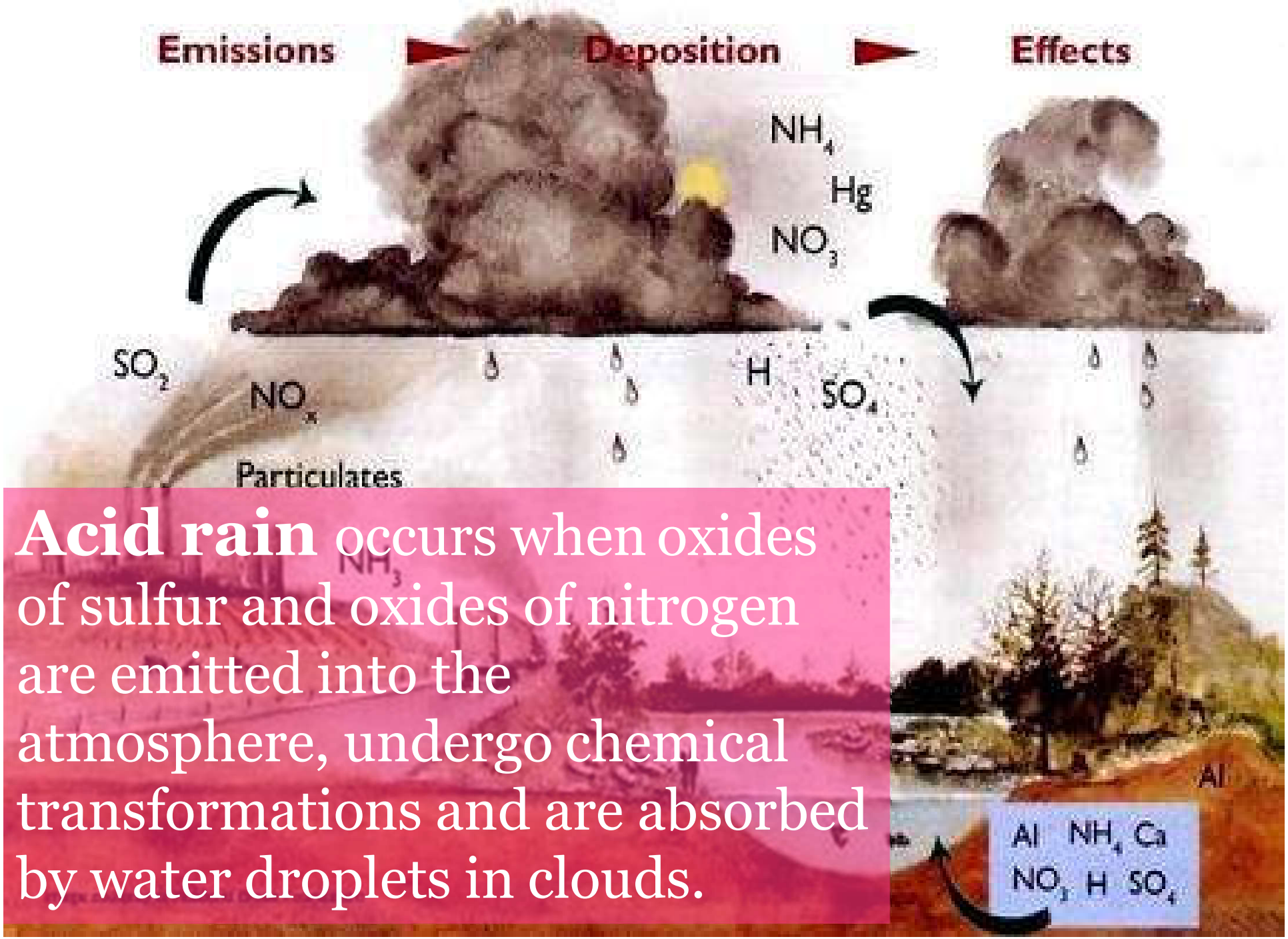


Chlorofluorocarbons & the ozone layer

- The ozone layer absorbs the Sun's high-energy ultraviolet (UV) radiation and protects the Earth.
- In the stratosphere, the CFCs break down and release chlorine.
- The chlorine reacts with ozone molecules, which normally block incoming ultraviolet radiation.

Chlorofluorocarbons (CFCs) and Ozone Depletion





Acid rain occurs when oxides of sulfur and oxides of nitrogen are emitted into the atmosphere, undergo chemical transformations and are absorbed by water droplets in clouds.

Effects of Acid Rain

- Acidification of bodies of water
- Damage of vegetation
- Damage to building materials, statues, etc.

GREENHOUSE EFFECT

The trapping of heat by gases in the atmosphere.

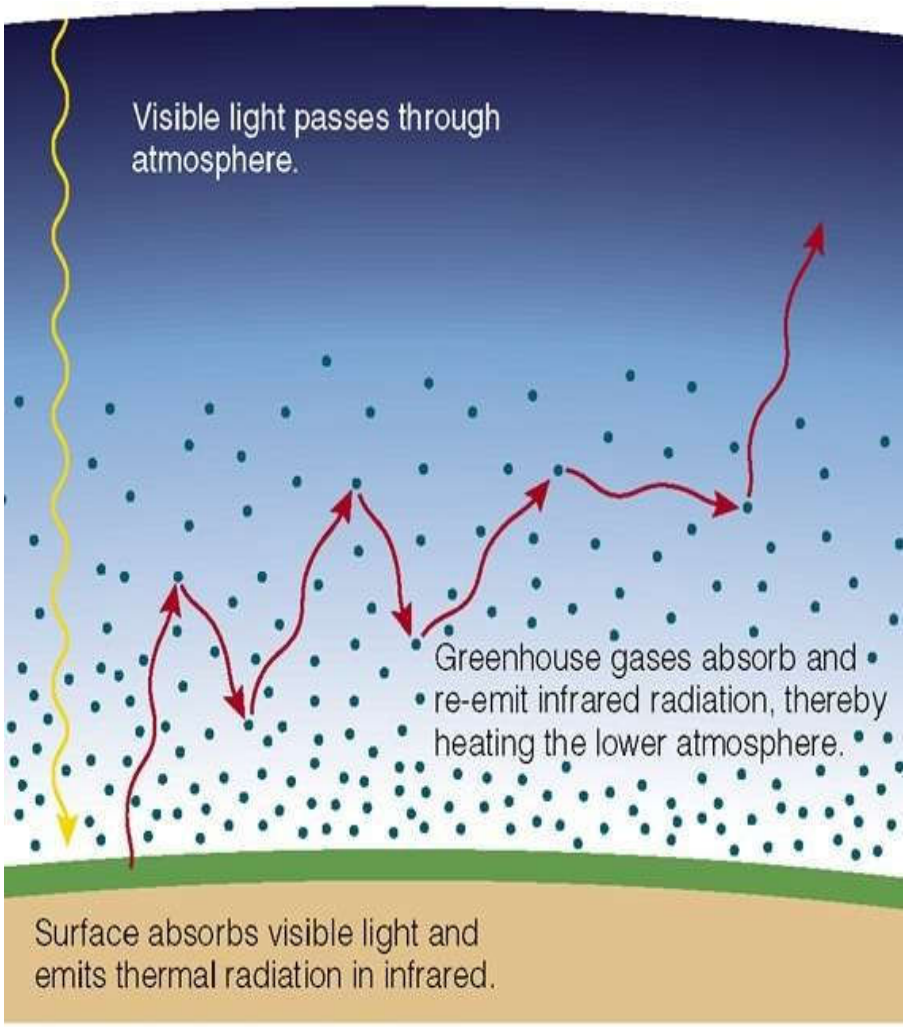
- **Naturally occurring greenhouse gases:**
  - *Water vapor*
  - *Carbon dioxide*
  - *Methane*
  - *Nitrous oxide*
  - *Ozone*
- **Greenhouse gases that are not naturally occurring**
  - *Hydro fluorocarbons* (HFCs)
  - *Per fluorocarbons* (PFCs)
  - *Sulfur hexafluoride* (SF_6)

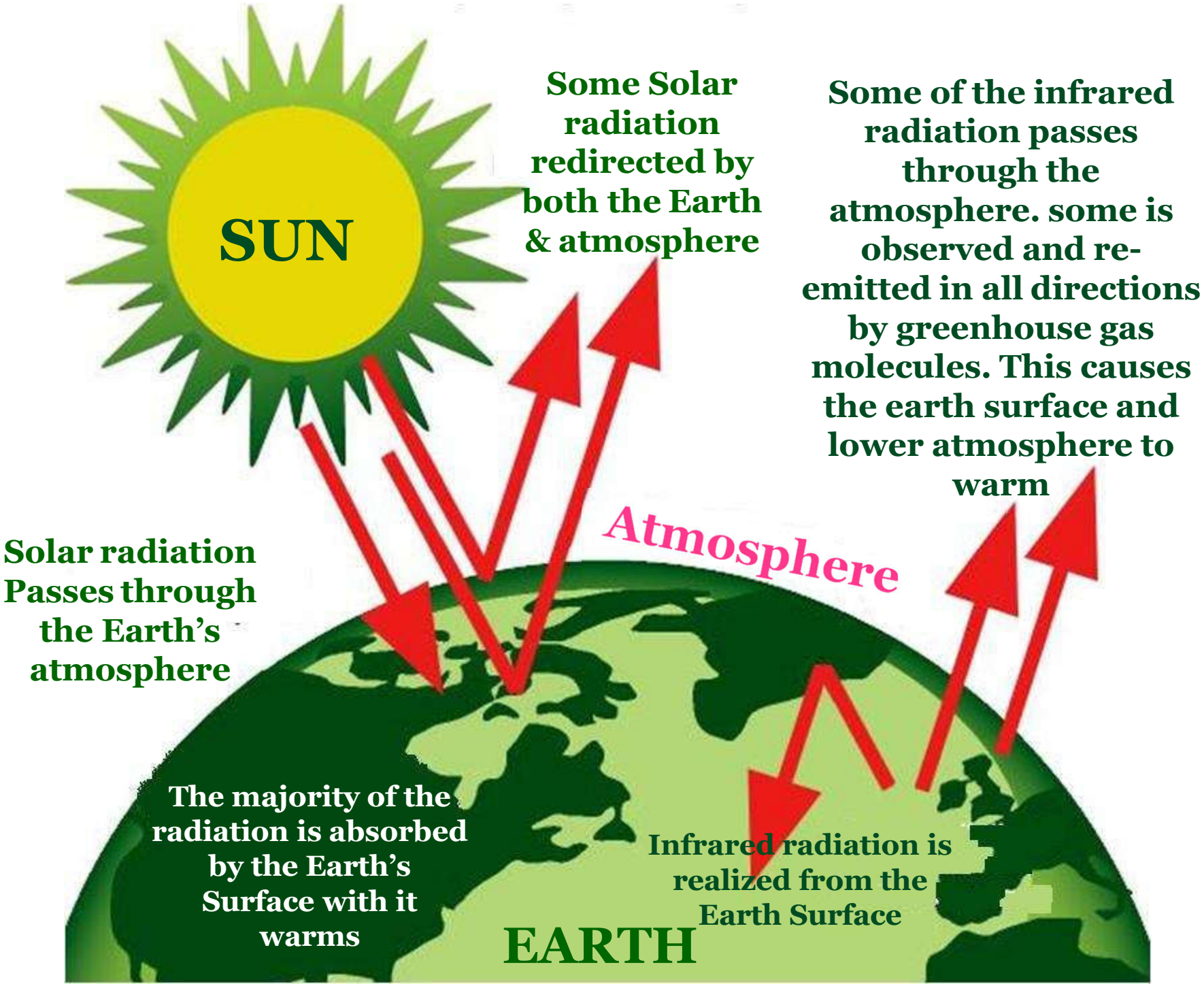
Generated in a variety of industrial processes.

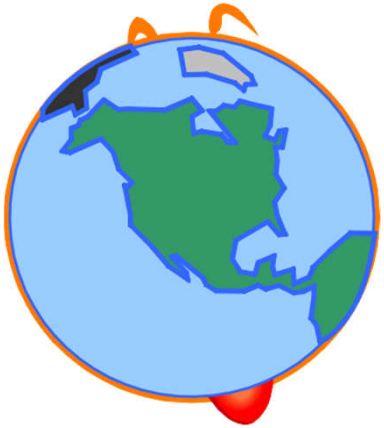
The Greenhouse Effect on Earth

Earth's atmosphere is slightly warmer than what it should be due to direct solar heating because of a ***mild case of greenhouse effect…***

- The ground is heated by visible and (some) infrared light from the Sun.
- The heated surface emits infrared light.
- The majority of Earth's atmosphere (N_2 and O_2) are not good greenhouse gas.
- The small amount of greenhouse gases (H_2O, CO_2) traps (absorb and re-emit) the infrared radiation, increasing the temperature of the atmosphere…

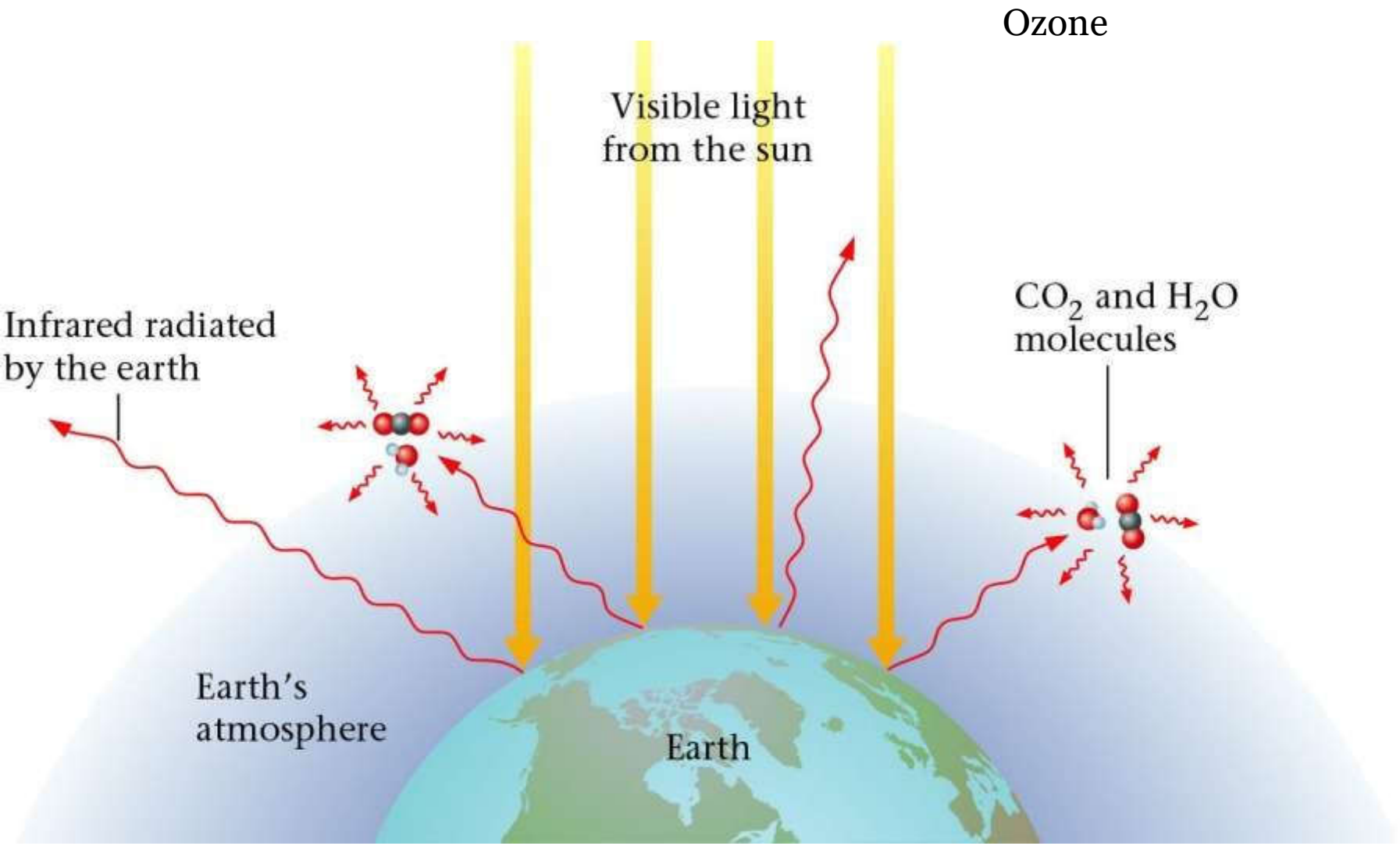



SUN
Some Solar radiation redirected by both the Earth & atmosphere
Some of the infrared radiation passes through the atmosphere. some is observed and re-emitted in all directions by greenhouse gas molecules. This causes the earth surface and lower atmosphere to warm
Atmosphere
Solar radiation Passes through the Earth's atmosphere
The majority of the radiation is absorbed by the Earth's Surface with it warms
Infrared radiation is realized from the Earth Surface
EARTH

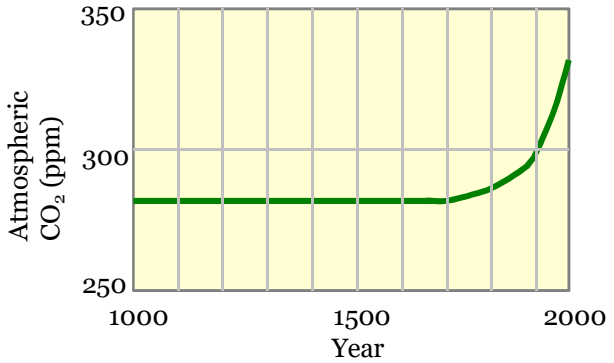


Greenhouse Gases

The Earths Atmosphere

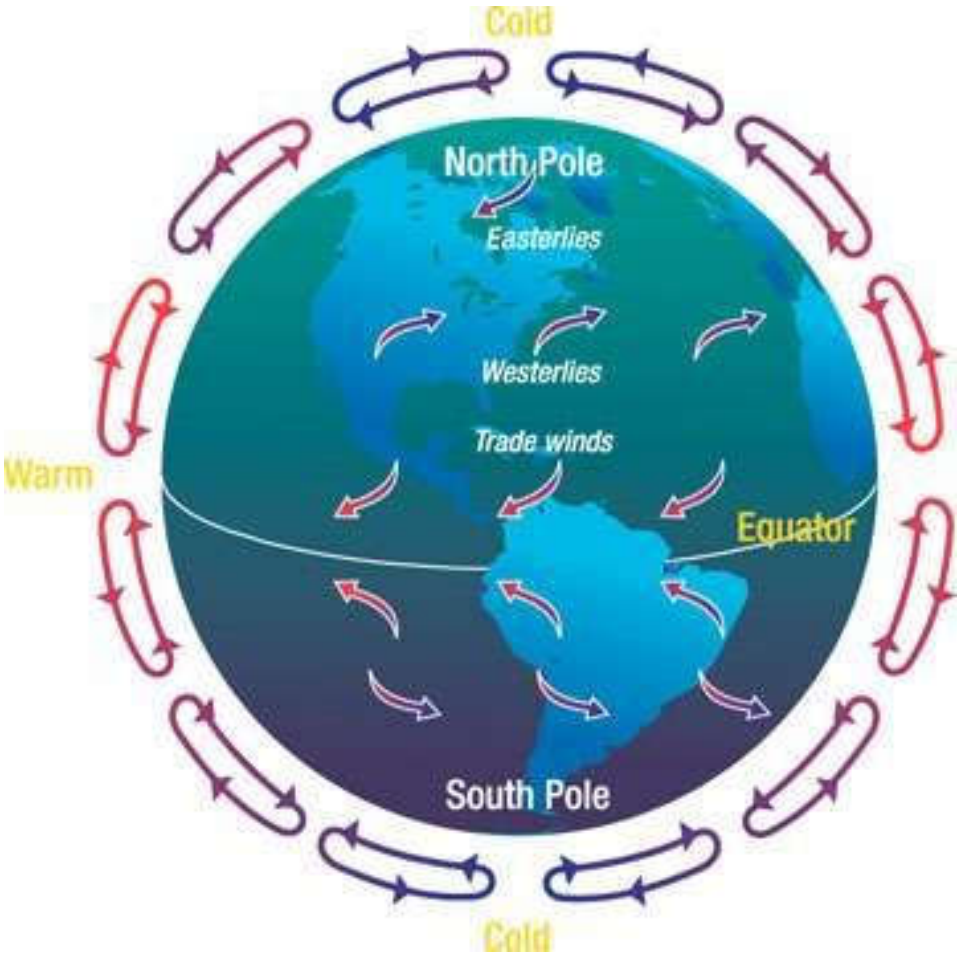


Greenhouse Effect



- FACT: 15% increase in [CO_2] in last 100 years
- **Cause**:
  - Change from agricultural to industrial lifestyle
  - Burning of fossil fuels (petroleum, coal)
  - Increase CO_2 emissions (cars, factories etc…)
  - Deforestation

- **Effects:**
  - Global warming
  - Melt polar ice caps → flooding at sea level
  - Warming oceans → more powerful storms


Cold
North Pole
Easterlies
Westerlies
Trade winds
Warm
Equator
South Pole
Cold

R Behera